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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 09/551,233      | 04/17/2000  | Katsuyoshi Matsuura  | FUJ 99228 CIP       | 9686             |

7590 03/07/2005

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EXAMINER

LEE, HSIEN MING

ART UNIT PAPER NUMBER

2823

DATE MAILED: 03/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/551,233

Applicant(s)

MATSUURA ET AL.

Examiner

Hsien-ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 05 January 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 12 and 15-17 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 12 is/are allowed.
- 6) ☒ Claim(s) 15-17 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

HSIEN-MING LEE  
PRIMARY EXAMINER

3/2/2005

**Attachment(s)**

- ☐ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### *Remarks*

1. The objection and 112-first-paragraph rejection to claim 15 are withdrawn.
2. Applicants' cancellation to claims 1-11, 13, 14 and 18-28 is acknowledged. Claims 12 and 15-17 are pending in the application.

### *Grounds of Rejection*

#### *Claim Rejections - 35 USC § 103*

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 15-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cuchiaro et al. in view of Izuha et al. (US 6,060,735) and Chu et al. (US 6,287,637).

Cuchiaro et al., in Fig.1 and related text, teach the claimed device, comprising:

- a substrate 102;
- an active device element 110 formed on a substrate 102 (Fig.1);
- an insulation film 114 provided over said substrate 102 to cover said active device element 110 (Fig.1);
- a ferroelectric capacitor comprising a lower electrode layer 116/120 containing Pt provided over said insulation film 114, wherein the lower electrode 116/120 comprises a *Ti layer 116* and a *conductor layer 120 (Pt)*;

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- a PZT ferroelectric film 122, having a *perovskite structure*, provided on said lower electrode 120; and
- an upper electrode 124 provided on said PZT ferroelectric film 122 (Fig.1).

Cuchiario et al. do not teach that said PZT ferroelectric film 122 has a *columnar* microstructure extending from an interface between said lower electrode 120 and said PZT ferroelectric film 122 is in a direction substantially *perpendicular to* a principal surface of said lower electrode 120, said PZT ferroelectric film 122 generally has a *<111> orientation* extending continuously from a bottom surface of said PZT ferroelectric film 122 to a top surface of said PZT ferroelectric film 122 and consisting of *crystal grains* generally having said *<111> orientation* and a substantially *uniform* grain diameter of *less than about 200 nm*.

However, Izuha et al. (Figs. 1-7), in an analogous art, teach the claimed semiconductor device, comprising a semiconductor substrate 1; a lower electrode 4 provided over the semiconductor substrate 1; a ferroelectric PZT film 5 on said lower electrode 4 (Fig.1), said ferroelectric PZT film 5 (col. 4, lines 52-53) having a *columnar* microstructure extending from an interface between said lower electrode 4 and said ferroelectric PZT film 5 (Fig. 4A) in a direction substantially *perpendicular to* a principal surface of said lower electrode 4 (col. 2, line 57 through col.3, line 45), said ferroelectric film 5 is extending continuously from a bottom surface of said PZT ferroelectric film to a top surface of said PZT ferroelectric film and consisting of *crystal grains* having a generally *uniform* grain diameter of *less than about 200 nm*, i.e. ranging from 5 to 500 nm (col. 6, lines 52-53 and Fig.4A).

Therefore, one of ordinary skill in the art, at the time the invention was made, would have been motivated to provide the semiconductor device of Cuchiario et al. having a columnar

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microstructure extending from the interface between the lower electrode and the ferroelectric film in a direction substantially perpendicular to the principal surface of said lower electrode, as taught by Izuha et al., since Cuchiario et al., and Izuha et al. have similar structure including a laminate film of the lower electrode, the ferroelectric dielectric and the upper electrode disposed in the order; and with the structure of Cuchiario et al., and Izuha et al. it would provide a lattice-matching structure, which, in turn, would reduce current leakage in the device (abstract, Izuha et al.).

Still, Cuchiario et al in view of Izuha et al. do not teach that the PZT ferroelectric film generally has a  $\langle 111 \rangle$  orientation and consists of crystal grains generally has the  $\langle 111 \rangle$  orientation.

Chu et al., however, teach the claimed ferroelectric PZT film and crystal grains with the  $\langle 111 \rangle$  orientation in a semiconductor device, which would improve electrical characteristics of the device (col. 3, lines 47-55).

Therefore, one of ordinary skill in the art, at the time the invention was made, would have been motivated to provide the semiconductor device of Cuchiario et al. in view of Izuha et al. having ferroelectric PZT film with a  $\langle 111 \rangle$  orientation and consisting crystal grains with the  $\langle 111 \rangle$  orientation, as taught by Chu et al., since by this manner it would provide a semiconductor device having better electrical properties.

*Allowable Subject Matter*

5. Claim 12 is allowed.
6. The following is a statement of reasons for the indication of allowable subject matter:

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The closest prior art of record, Cuchiario et al. (US 6,165,802), teach a method of fabricating a semiconductor device having a ferroelectric capacitor 118, as stated previously.

In contrast, Cuchiario et al. do not teach crystallizing the ferroelectric film under a reduced total pressure in the range between 1 Torr and 40 Torr such that peeling of the ferroelectric film is substantially reduced.

Chu et al. to US 6,287,637 teach crystallizing the PZT ferroelectric film under a reduced oxygen partial pressure atmosphere (col. 6, lines 41-47) in the range of  $10^{-4}$  to 100 Torr (col. 7, line 28), wherein the reduced oxygen pressure is a partial not a total pressure, i.e. the ambient for the crystallizing comprises *oxygen and argon, not pure oxygen*. Although Chu et al. do suggest that crystallizing the ferroelectric film can be performed in a pure oxygen ambient, Chu et al. do not teach the reduced total pressure of oxygen is in the range between 1 Torr and 40 Torr.

#### ***Response to Amendment***

7. The amendment filed 1/5/2005 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows:

“wherein a grain boundary of said crystal grains of said PZT film is staggered with respect to a grain boundary of crystal grains in said lower electrode”

Applicant is required to cancel the new matter in the reply to this Office Action.

*Response to Arguments*

8. Applicant's arguments filed 1/5/2005 have been fully considered but they are not persuasive.

Applicants' arguments is on the ground that cited references do not teach the amended limitation "wherein a grain boundary of said crystal grains of said PZT film is staggered with respect to a grain boundary of crystal grains in said lower electrode." However, the foregoing limitations lacks a support from the originally filed specification. On **page 19** of the specification, it merely states that "[i]n the cross-sectional morphology represented in **FIG.7B**, it can be seen that the **PLZT film 34** has a clear columnar microstructure extending **perpendicularly** to the principal surface of the underlying Pt electrode 33. Because of the columnar growth of the individual PLZT crystal grains, it can be seen that each crystal grain of FIG.7A is separated from neighboring crystal grains by a minute gap defining the grain boundary." (Emphasis added)

Applicants have referred to **Fig.7B** as a support for the foregoing amended limitation by asserting that 'the growth of the columnar PZT crystal grains starts from the "triple point" of the crystal grains of the platinum constituting the underlying electrode. In other words, the crystal grain boundary of the PZT crystal grains are "staggered" with respect to the crystal grain boundary of the platinum grains in the bottom electrode.' Applicants thus asserted that "in Izuha et al. there appears to be no teaching of a "staggered relationship between the grain boundaries of the PZT crystal grains and the bottom electrode crystal grains as claimed in claim 15." However, the specification discloses that the film 34 in FIG.7B is **PLZT**, **not PZT** as asserted; and says nothing about the "staggered with respect to a grain boundary of crystal grains

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in said lower electrode.” Even though applicants interpreted from FIG. 7B, the examiner is not able to recognize the “triple point of the crystal grains of the platinum” because the figure is **too dark and blur to tell** the claimed features.

For the reasons above, the rejection is still sustained.

### *Conclusion*

**9. THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on Tuesday-Thursday (8:00 ~ 6:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.



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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

March 2, 2005

Hsien-ming Lee  
Primary Examiner  
Art Unit 2823

**HSIEN-MING LEE**  
**PRIMARY EXAMINER**

*3/2/05*